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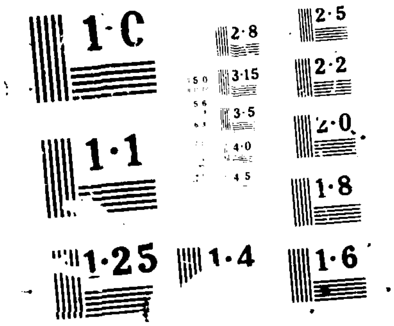
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Gottlieb

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The investigators pursued research on the use of spectral methods in computational fluid dynamics. In particular, he looked at their implementation for the solution of time dependent partial differential equation. Other topics pursued included the adaptation of spectral methods for compressible flow problems involving shocks, and the exploration of information content in spectral calculations. Papers produced during this effort included such titles as "Spectral methods for time dependent partial differential equations" "Recovering pointwise values of discontinuous data within spectral accuracy", and "Information content in spectral calculations".

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INTERIM SCIENTIFIC REPORT

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We have made progress in three areas

1) Spectral methods for discontinuities.

We have showed that for linear problems spectral methods yield highly accurate information even for problems with discontinuities. Appendix A is a summary of invited lectures given by Dr. Gottlieb at the Conference on Numerical Methods in Fluid Dynamics held at Reading, England in March 1985.

Basically, we showed that for linear problems the Fourier or Fourier-Chebyshev coefficient of the solution are obtained with spectral accuracy. We also showed several techniques to recover spectrally accurate pointwise values from the Fourier coefficients of discontinuous data. We have simulated also the wedge flow using the full Euler equations in 2D and found that also in this case the results contain spectrally accurate information.

2) Boundary conditions for incompressible flows.

We have developed simple techniques to achieve high order accurate time integrations for incompressible flow equations. The results are summarized in Apper!ix B.

3) We have carried out benchmark testing of large hydrodynamics code on supercomputers.

Spectral codes have been benchmarked on a large variety of American and Japanese supercomputers, including

Cray Research -	Cray 1S, Cray XMP24, Cray 2
Control Data -	Cyber 205-642
Hitachi -	Hitachi SA810/20
Fujitsu -	Fujitsu VP-200, VP-400
NEC -	NEC SX-2.

We have found that spectral hydrodynamics codes are highly vectorizable. They rely heavily on multi-dimensional fast Fourier transforms (FFTs).

The following performance was recorded:

SHEAR3 - Free-slip convection/shear flow code - 64^3 resolution

Cray 1S	80 MFlops (1 processor)
Cray XMP24	260 MFlops (2 processors)
Cray 2	1100 MFlops (4 processors)
Cyber 205	210 MFlops (1 processor)
Fujitsu VP-2[illegible]	140 MFlops (1 processor)
Fujitsu VP-4[illegible]	180 MFlops (1 processor)
Hitachi SA81[illegible]	110 MFlops (1 processor)
NEC SX-2	380 MFlops (1 processor)

Novel programming is sometimes necessary to take maximal advantage of some of the newer architecture machines. For example, on the Cray-2, it is necessary to make efficient use of the local 16K memories on each processor to achieve two simulataneous paths to memory and, hence, achieve full speed on FFTs.

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